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## (54) Improvements in or relating to discharge lamps

(57) The invention is an improvement of a folded fluorescent lamp 1 in which a tube is folded in a plane to surround a central housing 5 with the ends 4 of the tube re-entrant to be received by the housing. One of the tube ends has a long exhaust tip 13, within the housing, for mercury vapour pressure control. The housing is internally divided by a partition 21 through which the long exhaust tip 13, but not the tube ends 4, protrudes. This keeps the cool spot in the tip at a lower temperature than would otherwise be the case.

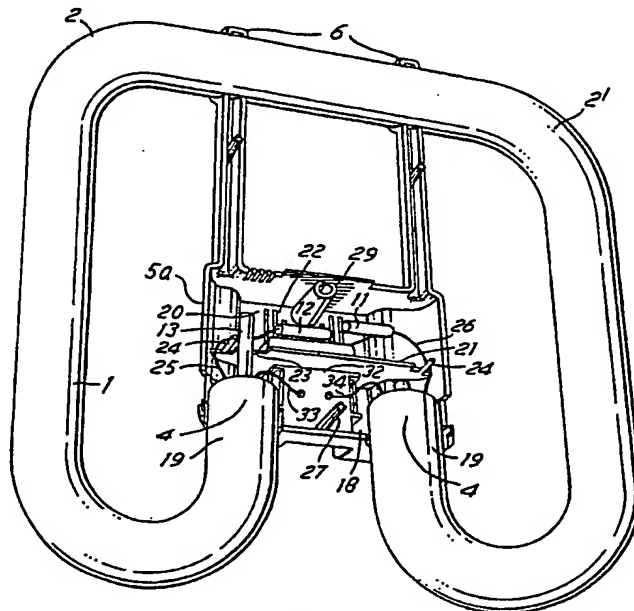


FIG. 4

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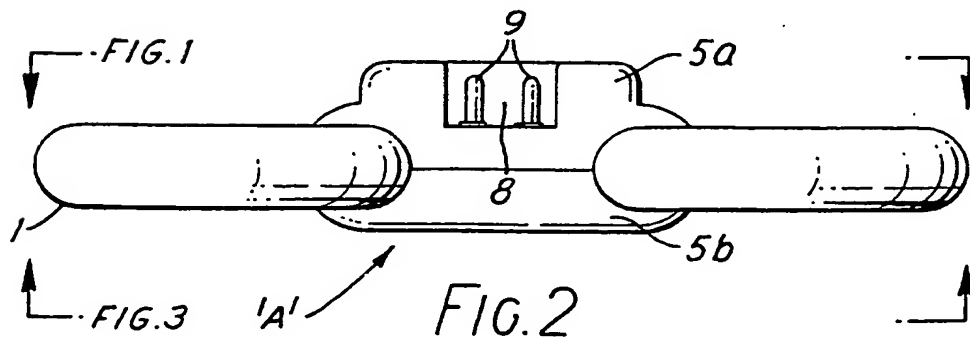
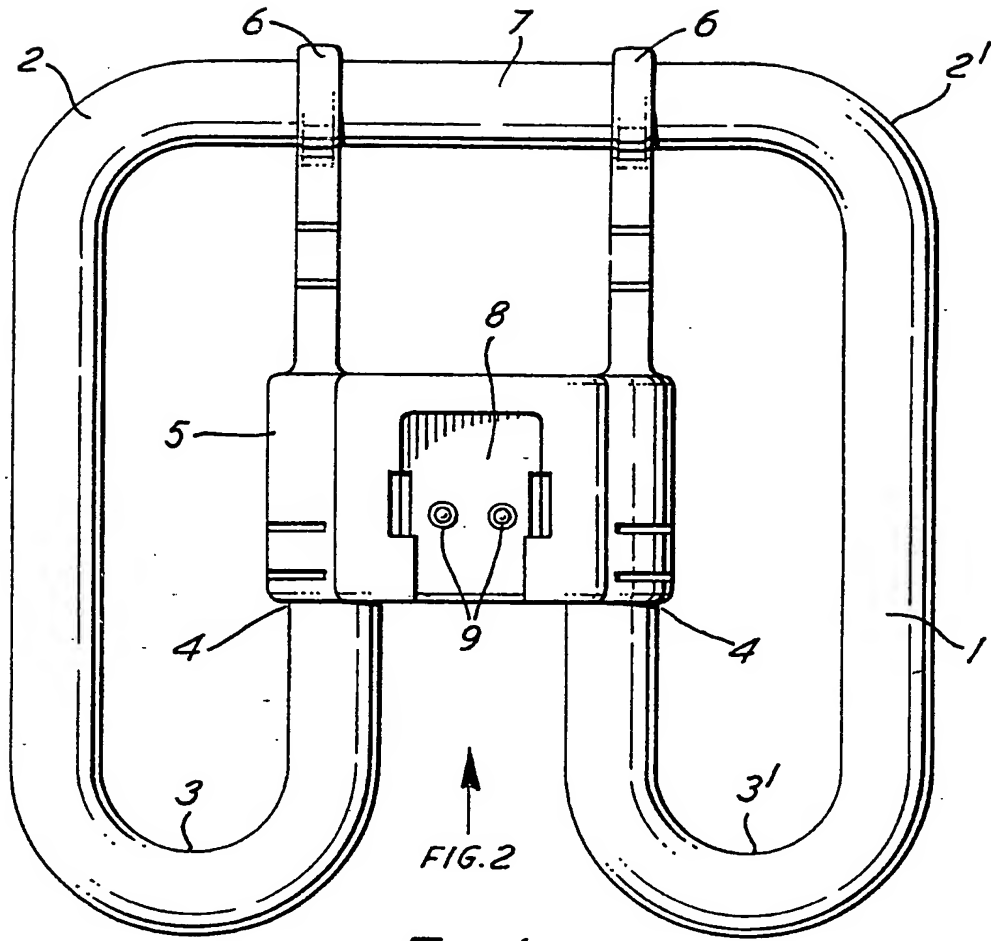


FIG. 1

FIG. 3

1A'

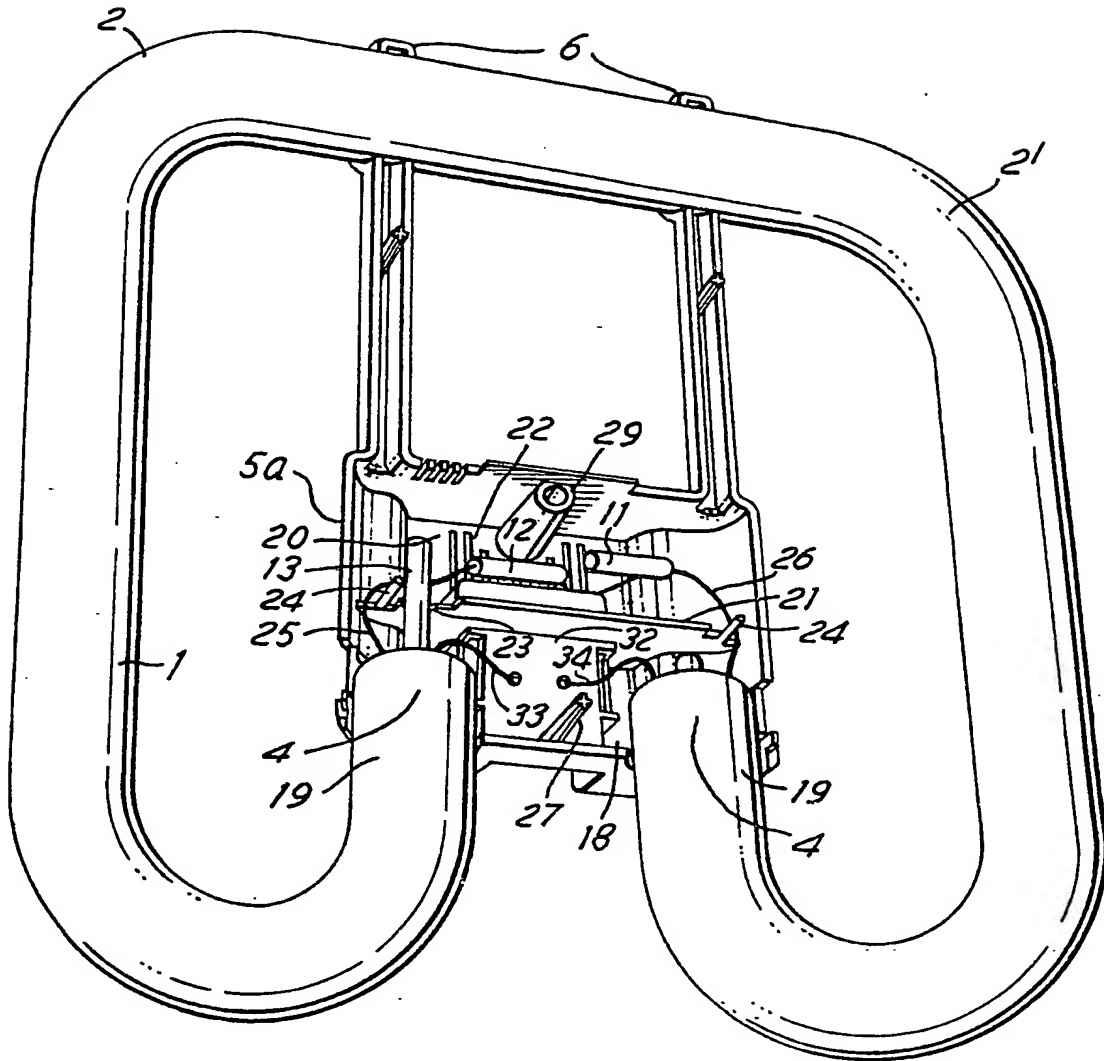
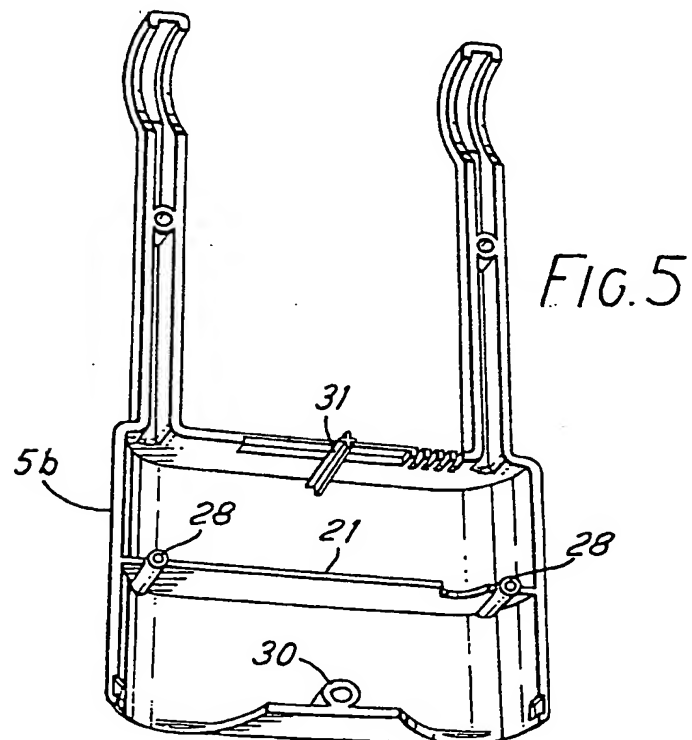
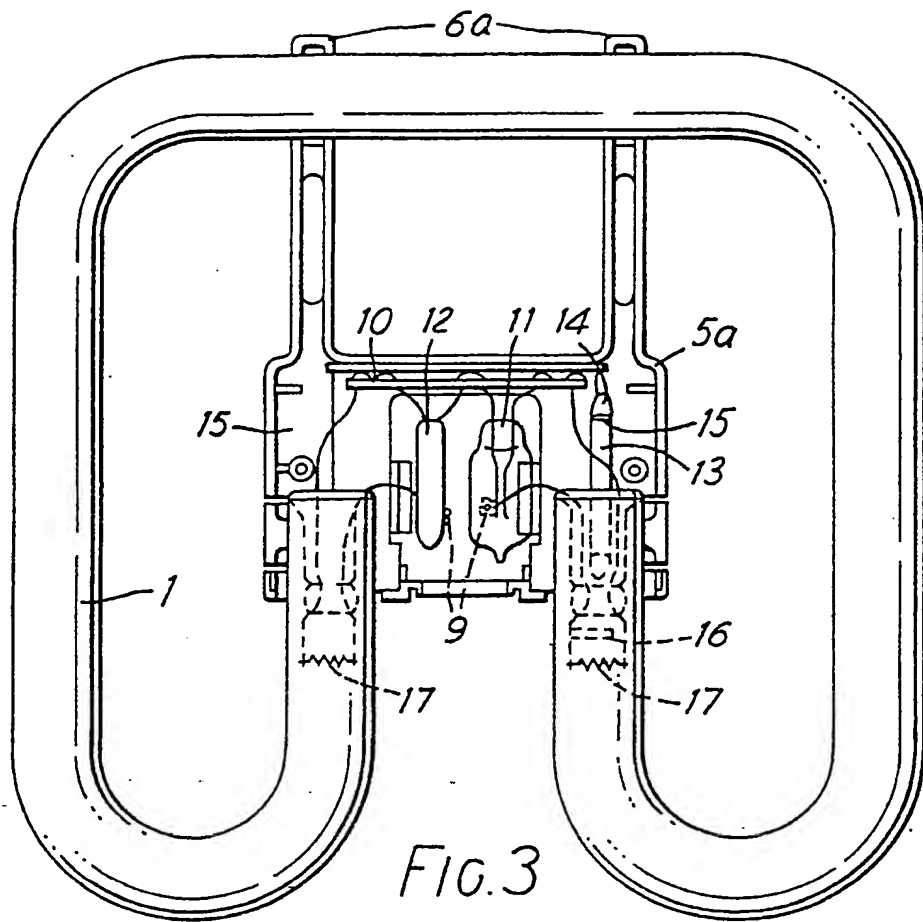


FIG. 4



## SPECIFICATION

## Improvements in or relating to discharge lamps

This invention relates to discharge lamps and in particular to fluorescent lamps of the type having a relatively lengthy discharge tube which is bent into a convoluted shape so as to be more compact. More particularly the invention is concerned with the type of discharge lamp disclosed and claimed in our European Patent Application No. 82 300112. The cool spot temperature for optimum performance of these lamps is a matter of choice and, of course, the wattage of the lamps will have an effect. In lamps with higher wattages there will be a greater heat input and the attainment of the desired cool spot temperature will be that much more difficult.

An object of this invention is to provide an improved discharge lamp of the type described above.

- 20 According to the invention there is provided a discharge lamp including a discharge tube, having an electrode at each end thereof, folded to define the boundary of a planar zone with said ends re-entrant into the zone, a lamp support housing
- 25 lying within the zone substantially in the plane and in which the tube ends are located, wherein one of the electrode ends includes a long exhaust tip, the lamp support housing is divided by a partition into two compartments and the tube ends are located
- 30 so that they each terminate in a first of said compartments and the long exhaust tip protrudes into and terminates in the second of said compartments.

- 35 Preferably the compartments are formed by a partition member moulded in-situ as part of the lamp support housing. This may be formed as part of each half of a two part lamp support housing which halves assemble together to form a single lamp support housing or a complete partition
- 40 member may be moulded in one half of a lamp support housing to be assembled with another half not having such a member.

Preferably also the partition member is shaped to form guide means for lead wires connected to

- 45 lamp electrodes within the lamp support housing. An embodiment of the invention will now be described way of example only and with reference to the accompanying drawings wherein:

- 50 Figure 1 shows a prior art lamp in underplan, Figure 2 shows the lamp of Figure 1 in end elevation,

Figure 3 shows the lamp of Figure 1 and 2 in plan view with the lamp support housing cover removed to reveal electrical components,

- 55 Figure 4 is a perspective view of a discharge lamp according to the present invention looking in the direction of arrow "A"; Figure 2, and with its half cover removed, and

- 60 Figure 5 is a perspective view of half of a lamp support housing which cooperates with the half lamp support housing shown in Figure 4.

A fluorescent lamp in accordance with this example of the invention is shown in underplan

- 65 and end elevation respectively in Figures 1 and 2. Considering these two Figures together, the discharge tube 1, which is otherwise of conventional type for a fluorescent tube, is bent through 90° at 2, 2' to form three sides of a
- 70 rectangle, in this example a square. The tube is further bent at 3 and 3' but at these points through 180° so that the ends 4 of the discharge tube are re-entrant into the square formed thereby. This tube is considered to define the
- 75 boundary of a square zone, the break in the boundary necessitated by the re-entrant ends being disregarded. All bends are about parallel axes so that the resultant tube shape is flat, that is the tube lies in a plane of thickness substantially
- 80 equal to the tube diameter.

- Inside the square formed by the folded tube there lies in this example a lamp support housing 5 into which the ends 4 of the discharge tube 1 are fitted. The housing 5 encloses starter
- 85 components and electrical connections and is formed in two parts 5a and 5b which press together for ease of assembly. Part 5a is, in this example, that on which the starter and connections are mounted and part 5b is formed as
- 90 a simple cover. The housing is formed with arms 6, in this example two, which each terminate in a circular support gripping the tube 1 in its centre section 7. These are also in two parts each associated with one of the parts of the housing 5
- 95 to enclose the tube when they are pressed together.

- Visible also in Figure 1 and 2 is a recess 8, in the upper part 5a of housing 5, to accommodate a lamp holder and therein are two terminal pins 9.
- 100 The recess 8 and terminals 9 may take any suitable form as required.

- The arrangement illustrated in which housing 5 includes two arms 6 gripping the centre part 7 of tube 1 is considered to give effective support to
- 105 tube 1 to prevent relative movement of discharge tube and housing during handling. It is particularly advantageous in handling since it provides a convenient, and therefore natural, point at which to grip the lamp, reducing the risk of handling of the tube itself. It is also advantageous in not
- 110 requiring excessive precision in placement of the ends of the tube at assembly, the arrangement gripping the tube ends in the position in which they lie and not forcing them to a predetermined
- 115 exact position. Bearing this in mind less or no support may be provided for applications in which tube support and tube are held together by other means, for example an adhesive material. Alternative positions of the arms may also be
- 120 used. For example one supporting arm could be provided to each of the three straight tube sections although such a configuration reduces ease of assembly.

- Figure 3 shows a plan view of the lamp, that is from the opposite side to Figure 1, with the cover part 5b removed to reveal the components mounted within the housing 5.

Visible in this Figure are circuit wiring, in this example a printed circuit board 10, on which are

mounted, where required, elements such as a glow switch 11 and a radio interference suppression capacitor 12, both of well known type. The printed circuit board may be replaced by other means of making electrical connections and a lamp such as that of this invention can work satisfactorily without capacitor 12 or with the starter switch and capacitor situated externally of the lamp. It will be appreciated that the contents of housing 5 may be varied at will within the scope of this invention and may, advantageously, comprise an electronic ballast. Similarly the two terminal pins may be supplemented by other pins if the circuits used with the lamp should require them. Means are also provided to cooperate with complementary means on the other half housing 5b to facilitate the assembly of the two half housings 5a and 5b.

The lamp exhaust tube, shown at 13 between electrical connections to a tube electrode, is substantially longer than is usual for such a discharge tube. This long exhaust provides a cool spot for the condensation of the reservoir of liquid mercury which must be available for partial vaporisation and use during the life of the lamp and the temperature of which determines the mercury vapour pressure. The length of the exhaust is chosen to ensure near optimum performance of the lamp. It avoids, for example, the necessity to form an additional or separate appendix, such as shown in British Patent Specification 2033653B. The exhaust tube in the example illustrated is tipped-off with a solid glass tip-off 14 and droplets of condensed mercury lie at 15, after the lamp has been run for a sufficient period. Such a long exhaust may be provided at each end of the discharge tube although such an arrangement is not favoured.

Vapour pressure control could be provided by use of the known mercury amalgam system, but this is more complicated. A well known getter/mercury dispenser ring can be used for the introduction of a small controlled mercury dose. This ring, comprises a nickel plated iron container having in it a mixture of "ST101" (Zr/Al getter) and mercury/titanium alloy. The small mercury dose, introduced as a vapour, has special advantages in relation to a compact domestic lamp. For example it reduces the risk of damage to the phosphor at the bends by a rolling mercury drop and provides faster stabilisation of the lamp.

It also reduces the quantity of mercury which may be released into the environment, which is particularly advantageous in domestic situations.

In the example of this lamp the preferred gas fill is argon in the range 2 to 7 torr, 5 torr being considered most suitable. The mercury dose is in the range 1—7 mg.

The discharge lamp thus far described operates satisfactorily, however, as previously mentioned the higher the wattage the greater is the problem of attaining the selected temperature for optimum lamp operation. With a lamp wattage, say, of 28 watts and above it is desirable to aim at a

lamp operation. That is the temperature of the cool spot at the long exhaust tip should be 45°C. With the design of lamp support housing shown in Figure 3 it has been found that for an ambient temperature in the area of the lamp of 45°C the temperature within the lamp support housing can be as high as 59°C. This is too high to allow the lamp to operate with a temperature at the long exhaust tip of 45°C. Moreover with the design of lamp support housing shown in Figure 3 there is just the possibility of lead wires from the electrodes touching each other and shorting out the lamp. Both of these problems have been alleviated with the design of lamp support housing shown in Figures 4 and 5.

A discharge lamp in accordance with one embodiment of the present invention is partly shown in Figure 4 and comprises a half lamp support housing 5a having a first compartment 18 in which the ends 4, comprising electrode ends 19, are situated. The long exhaust tip 13 terminates in a second compartment 20. The length of the termination of the tip within compartment 20 will vary depending on the desired optimum lamp performance but it is expected that it will be between 10 to 17 mm. In the embodiment shown the first and second compartments 18 and 20 respectively are formed by a partition member 21 moulded in-situ in each of the halves 5a and 5b of the lamp support housing 5. It has been found that the compartment 20 is significantly cooler, up to 9°C cooler, than compartment 18 so that the long exhaust tip can operate in compartment 20 at the desired 45°C. On the embodiment illustrated slotted vents 22 are included to assist the cooling process. However, surprisingly, it has been found the vents 22 make little contribution to the cooling effect compared to the cooling effect achieved by the partition of the lamp support housing. The partition 21 is recessed at 23 to accommodate the circular long exhaust tip 13.

In accordance with a further aspect of the present invention it will be seen from Figure 4 that the lamp support housing half 5a includes outstanding pin members 24 moulded as part of the partition member 21. These pin members form guide members for lead wires 25, 26 leading to electrical components such as capacitor 12 or glow switch starter 11 respectively. The provision of guide members for the lead wires 25, 26 effectively prevents the lead wires touching each other and short circuiting the lamp. The pin members 24 also act as locating members facilitating the assembly together of the two lamp housing support halves 5a and 5b, since they can be used in conjunction with tubular receptacles 28 moulded as part of half lamp support housing 5b on partition member 21 as best seen in Figure 5. To facilitate the assembly together of the two half lamp support housings 5a and 5b male, female locating members 27, 28 shown in Figure 4 cooperate with female, male locating members 30, 31 respectively shown in Figure 5. Reference numeral 32 represents the bottom of the recess

temperature of 45°C for the ambient optimum

portion 8 (Figure 2) which carries terminal pins 9 lead wires 33, 34 connect the electrodes ends to the terminal pins 9 through the bottom of the recess 32.

- 5 The preferred method of construction of tube 1 into the shape of the invention is by taking a straight tube internally coated with a suitable phosphor in conventional manner, heating it near the ends and bending it in those regions through 180° and repeating the process to bend it again at the 1/3rd points through 90°. The bends in the tube are relatively sharp but are still of course curved as limited by practical considerations. During bending it is essential that the tube should be pressurised with a suitably inert gas to prevent the softened tube collapsing at the bends.

- 10 The tube may be of soda-lime glass as is usual for fluorescent lamp tubes or it may be of any other material suitable for making discharge tubes. For the example shown in Figures 1 to 4 the tube is preferred to be of diameter 18.2 to 18.6 mm (OD) (preferably 18.3) and about 1.0 mm wall thickness. The preferred centre line length after bending is about 720 mm between the cathodes and with this length the lamp defines a square of about 200 mm.

- 15 Although Figures 1 to 3 illustrate one suitable tube shape for use with the embodiment of the invention shown in Figure 4, the invention is applicable to many other shapes of tube which may be disposed around a support housing. It is not necessary for sides of the zone defined by the tube to be parallel or for all sides to include straight portions. The preferred shapes are those in which the parts of the tube defining the boundary of the zone, as distinct from the re-entrant ends, include at least one straight portion which has not been directly subject to the stresses of bending.

- 20 The embodiment illustrated by Figure 4 is, however, particularly preferred.

- It will be understood, for all examples of the lamp with which the invention is intended to be used, that deviations of the convoluted tube from the plane in which it generally lies are envisaged provided they are not excessive. It is not envisaged that such deviations would be substantially greater than one tube diameter or the advantages of a generally flat lamp may be lost. The support housing may, however, be out of the plane of the tube, at least in part and the ends 4 of the tube may then deviate from the general plane sufficiently to enter the support housing. Such an arrangement, although not favoured, does have

- 55 the advantage of reducing interception by the support housing of light on paths, passing to the side of and below the lamp. The arms may be repositioned to accommodate the displaced support housing.

- 60 Other minor deviations may be tolerated, for example for aesthetic reasons or for reasons of convenience of manufacture.

- Although the present invention is particularly advantageous in the field of lamps of dimensions approaching those of general lighting service filament lamps it may be applied with advantage to lamps of very different dimensions larger and smaller including, but not limited to, the well known 26 mm and 38 mm diameter tubes. For such tubes it will be realised not only that the dimensions will be different to those given hereinbefore for the embodiment of Figures 1—4 but also that other figures given, such as those for gas fill pressure and mercury dose, will generally be different.

#### CLAIMS

1. A discharge lamp including a discharge tube, having an electrode at each end thereof, folded to define the boundary of a planar zone with said ends re-entrant into the zone, a lamp support housing lying within the zone substantially in the plane and in which the tube ends are located, wherein one of the electrode ends includes a long exhaust tip, the lamp support housing is divided by a partition into two compartments and the tube ends are located so that they each terminate in a first of said compartments and the long exhaust tip protrudes into and terminates in the second of said compartments.
2. A lamp according to Claim 1 wherein the partition is a member moulded as part of the lamp support housing.
3. A lamp according to Claim 2 in which the lamp support housing is formed in two parts and the partition member is formed in two parts one on each of said housing parts.
4. A lamp according to Claim 2 in which the lamp support housing is formed in two parts and the partition is formed as a single member on one only of said housing parts.
5. A lamp according to any preceding claim in which the partition is shaped to provide guide means for wiring located in the housing.
6. A discharge lamp substantially as herein described with reference to Figures 4 and 5 of the accompanying drawings.